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Comparative Study of Seismic Behavior of Staggered Opening and Conventional Opening Shear Wall in Multistory Building

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Abstract – *In India the land problem is increasing day by day with respect to increase in population. More than horizontal structures vertical structures have more demand and with the increase in height of the structures, it is subjected to lateral loads as well as seismic loads. In multistoried building shear wall is the effective solution to improve its structural behavior. Shear wall can be provided in many ways such as shear wall with openings, shear wall without openings etc. From studies it is find out that staggered opening shear wall reduces dead weight and improves seismic behavior of the buildings. In this study the shear walls with openings are provided in different positions of the building under earthquake loads. A G+9 storied building with staggered opening and conventional opening shear wall is positioned at centre and periphery is analyzed dynamically in Seismic Zone II. To sustain lateral force shear wall is the best method. This analysis is done to compare the behavior of structure having shear wall at different positions. Openings are provided for the shear wall for the purpose of doors, windows etc. The parameters like Storey Displacement, Base Shear, Storey Drift, and Stiffness are compared using Etab Software.*

Key Words: Shear Wall, Openings, RC building, Displacement, Drift, Base Shear

1. INTRODUCTION

The use of shear wall structure has gained quality in high rise building structure, particularly within the construction of office/commercial tower. RC multistory building with shear wall is commonest technique to satisfy the population wants and for safety of the structure underneath any loading conditions similarly as earthquake .Shear wall is also outlined as structural parts, which offer strength, stiffness and stability against lateral masses gaining strength and stiffness. Shear walls will effectively resist horizontal forces. Behavior of such kind of RC building with provision of shear wall is completely different than the common RC structures. Therefore it's necessary to analyze the structure with provision of shear wall. Shear walls square measure one in every of the foremost efficient lateral force resisting parts in multi-storied buildings. By introducing shear wall the building become safe, sturdy and conjointly additional stable the most role of shear wall is to boost rigidity for the lateral masses by the result of wind and earthquakes. The staggered-wall system consists of a series of storey-high RC walls spanning the full breadth between 2 rows of exterior columns and organized in a very staggered pattern on adjacent column lines. With the columns solely on the outside of the building, a full breadth of column free space may be created. Compared with ancient shear wall structures, the structures with vertical walls placed at alternate levels have advantage for his or her enhanced spatial flexibility. In India, IS 1893 (Part1) Criteria for Earthquake Resistant style of Structures is employed as code of observe for analysis & coming up with of earthquake resistant buildings. Unstable force depends on the mass and unstable constant of the structure and the latter successively depends on properties like unstable zone within which structure lies, importance of the structure, its stiffness, the soil on that it rests, and its malleability.

1.1 Shear wall

A shear wall could be a vertical structural component that resists lateral forces within the plane of the wall through shear and bending. Shear wall, in building construction, a rigid vertical diaphragm capable of transferring lateral forces from exterior walls, floors, and roofs to the bottom foundation in an exceedingly direction parallel to their planes. Examples square measure the reinforced-concrete wall or vertical truss. Lateral forces caused by wind, earthquake, and uneven settlement hundreds, additionally to the load of structure and occupants, produce powerful twisting (torsional) forces.

- Shear walls square measure particularly vital in high-rise buildings.
- In residential buildings, shear walls square measure external type a box that provides all of the lateral support for the building.
- Resist lateral hundreds, unstable hundreds, vertical Forces (gravity).
- Reduces lateral sway of the building.

A shear wall could be a structural system composed of braced panels (also known as shear panels).Reinforced concrete (RC) buildings typically have vertical plate-like RC walls referred to as shear walls additionally to slabs, beams and column. These walls square measure accustomed counter the results of lateral load performing on a structure. Wind

and unstable hundreds square measure the foremost common hundreds that shear walls square measure designed5 to carry. Shear walls resist in-plane hundreds that square measure applied on its height. The applied load is usually transferred to the wall by a diaphragm or collector or drag member to the inspiration. Shear walls square measure straightforward to construct, because reinforcement particularization of walls is comparatively straight-forward and thus simply implemented at web site. Constructions fabricated from shear walls square measure high in strength, they majorly resist the unstable force, wind force and even are often designed on soils of weak bases by adopting varied ground improvement techniques. Not solely the quickness in construction method however the strength parameters and effectiveness in touch horizontal hundreds is incredibly high. Shear walls typically employed in earth quake prone areas, as they're extremely economical in taking the hundreds. There square measure plenty of literatures obtainable to style and analyze the shear wall. However, the choice regarding the situation of shear in close a high-rise building isn't a lot of mentioned in any literatures. There square measure several code packages that square measure obtainable to find and style the shear in close a structure such as ETABS.

1.2 Objective

The main objective of this study is to achieve insight into the performance of the shear wall of a high rise structures underneath lateral load due to earthquake. To review the seismic behavior of staggered opening shear wall comparison with conventional opening shear wall in a high rise structure. The performance and response of building with typical and staggered openings are applied. Dynamic analysis is carried by response spectrum method. RC Frame of G+9 stories has been taken for analysis. The subsequent points are studied during this work.

1. Stiffness
2. Base shear
3. Displacement
4. Drift

2. MODEL SPECIFICATION

A G+9 storied reinforced concrete building with conventional and staggered opening shear wall has been considered for the present work. A Multi-storey building without shear wall and multi-storey buildings with conventional and regular opening shear walls in different positions. All these buildings of different openings and different positions are at zone 2 as per codal provisions. The seismic analysis of the structures are by response spectrum method at different positions of shear wall. Modelled using ETABS 2018 software as per IS 1893-Part 1(2002) codal provisions are considered for seismic analysis of developed building models and IS 875-Part 1 (1987) for dead load and live load as per IS875-Part 2(1987) and the shear wall requirements given in IS 13920: 1993 code book.

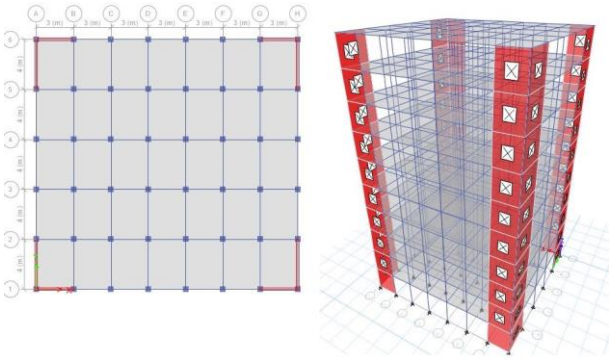

Fig 01 : Conventional opening shear wall at periphery

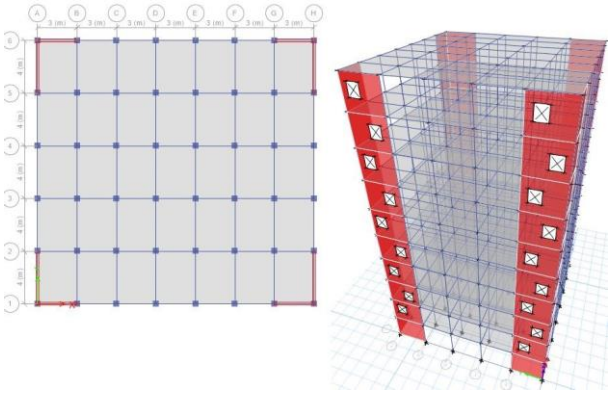

Fig 02 : Staggered opening shear wall at periphery

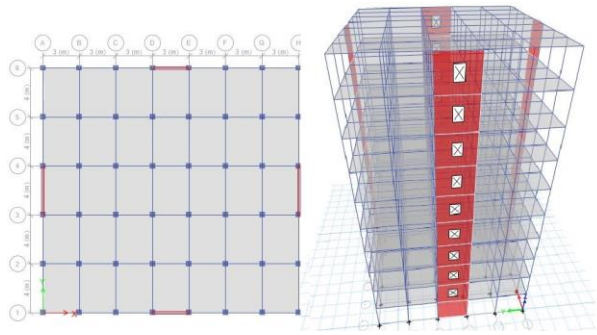

Fig 03 : Conventional opening shear wall at centre

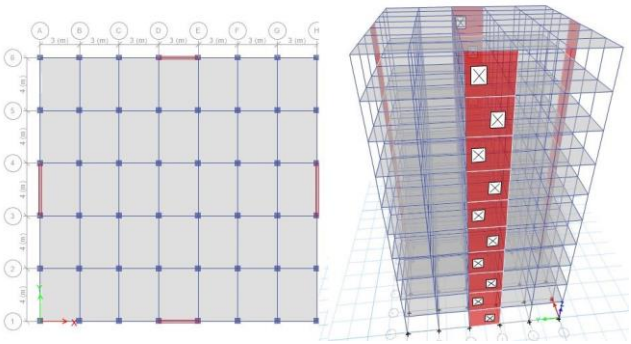

Fig 04 : Staggered opening shear wall at centre

3. Building parameters

No. of storey : 10
Size of Column : 450 x 450 mm
Size of Beam : 300 x 450 mm
Depth of Slab : 150 mm
Thickness of Shear Wall : 200 mm
Height of each storey : 3.5 m
Support condition : Fixed at base
Grade of concrete : M25
Grade of steel : Fe415

Unit weight of the concrete : 25 kN/m3
Live load : 3 kN/m2
Floor finish : 1 kN/m2

Seismic zone : Π
Importance factor (I) : 1.2
Zone factor (Z) : 0.36
Type of soil : Medium
Damping ratio : 5%
Response reduction factor (R) : 5

4. RESULTS

Table -1: Storey displacement for Conventional Opening Shear Wall

SR NO.	DIRECTION	Conventional opening at periphery	Conventional opening at centre
1	X DIR.	52.082	50.824
2	Y DIR.	44.29	49.687

Table -2: Storey displacement for Staggered Opening Shear Wall

SR NO.	DIRECTION	Staggered opening at periphery	Staggered opening at centre
1	X DIR.	40.392	51.89
2	Y DIR.	34.205	50.287

Table -3: Storey Drift for Conventional Opening Shear Wall

SR NO.	DIRECTION	Conventional opening at periphery	Conventional opening at centre
1	X DIR.	0.001795	0.001874
2	Y DIR.	0.001551	0.001759

Table -4: Storey Drift for Staggered Opening Shear Wall

SR NO.	DIRECTION	Staggered opening at periphery	Staggered opening at centre
1	X DIR.	0.001393	0.001896
2	Y DIR.	0.001204	0.001773

Table -5: Storey Shear for Conventional Opening Shear Wall

SR NO.	DIRECTION	Conventional opening at periphery	Conventional opening at centre
1	X DIR.	4789.404	3672.597
2	Y DIR.	4679.547	3568.956

Table -6: Storey Shear for Staggered Opening Shear Wall

SR NO.	DIRECTION	Staggered opening at periphery	Staggered opening at centre
1	X DIR.	3778.227	3718.891
2	Y DIR.	3693.403	3597.196

Table -7: Stiffness for Conventional Opening Shear Wall

SR NO.	DIRECTION	Conventional opening at periphery	Conventional opening at centre
1	X DIR.	2134408	1417004
2	Y DIR.	2922765	1737269

Table -8: Stiffness for Staggered opening shear wall

SR NO.	DIRECTION	Staggered opening at periphery	Staggered opening at centre
1	X DIR.	2271826	1197628
2	Y DIR.	3114181	1557160

4. GRAPH

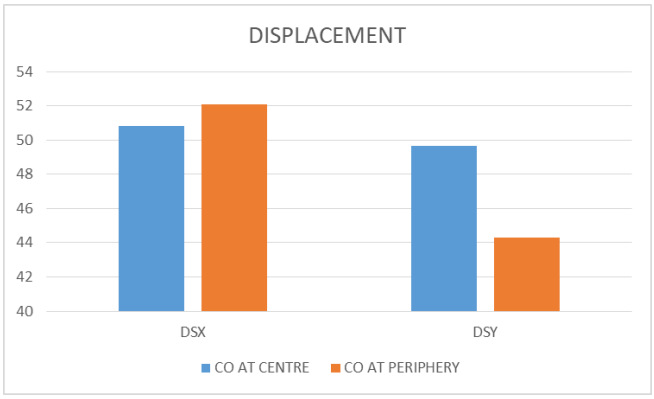

Chart -1: Storey Displacement of Conventional opening shear wall

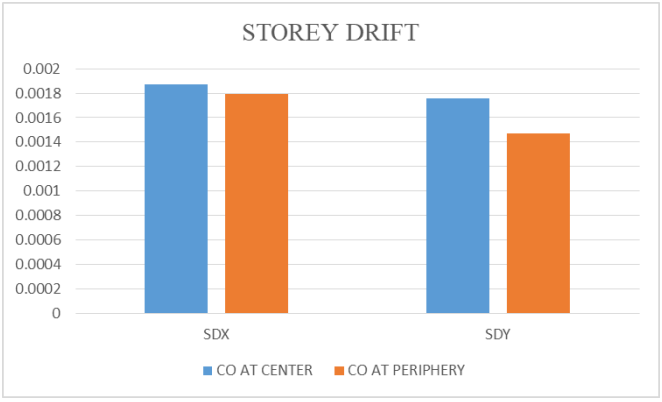

Chart -2: Storey Drift of Conventional opening shear wall

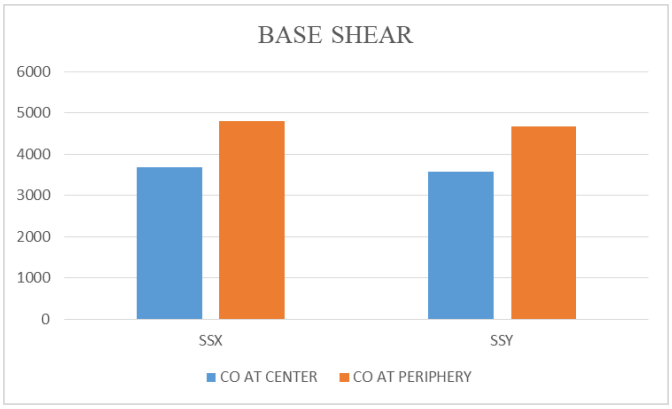

Chart -3: Storey Shear of Conventional opening shear wall

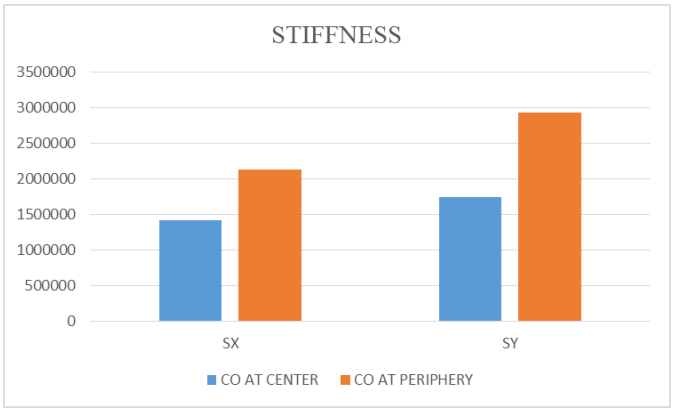

Chart -4: Stiffness of Conventional opening shear wall

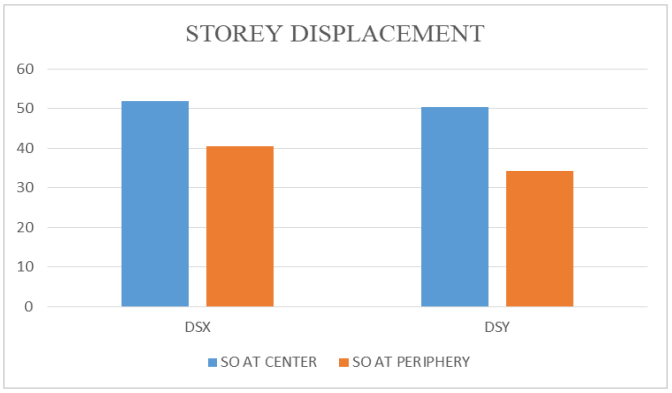

Chart -5: Storey Displacement of Staggered opening shear wall

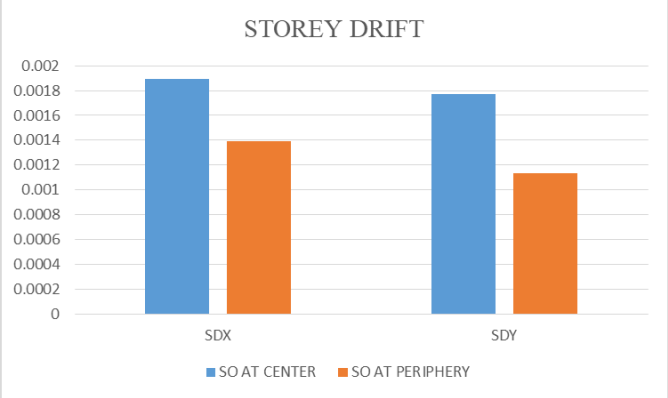

Chart -5: Storey Drift of Staggered opening shear wall

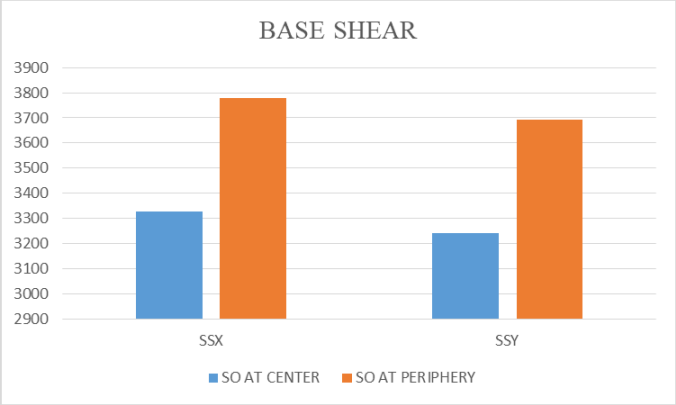

Chart -6: Storey Shear of Staggered opening shear wall

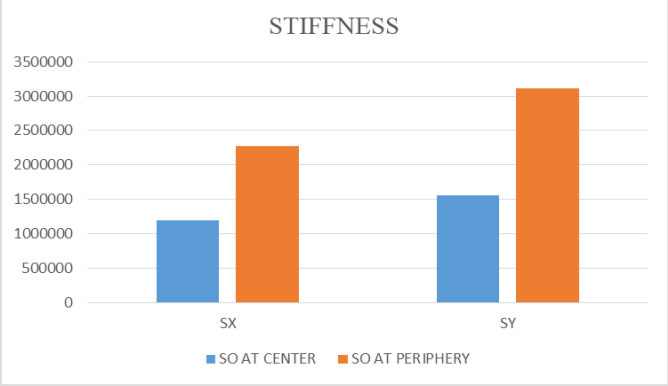

Chart -6: Stiffness of Staggered opening shear wall

5. CONCLUSIONS

It's clear that it's higher to provide opening in edge rather than opening provided at centre. And just in case of providing the opening we tend to perpetually ought to keep company with staggered opening shear wall as a result of it offers higher performance against earthquake in Displacement, drift and base shear. Therefore we will concluded that regular building with shear wall having staggered gap shows higher leads IN terms of displacement, drift and storey shear The displacement and drift in staggered openings united quite well than that of vertical openings. The shear wall with staggered openings is rigid and appears to develop a ductile behavior, whereas the shear wall with vertical openings appears to develop a brittle behavior. The bottom shear in shear wall with staggered openings is way lesser compared to shear wall with vertical openings. The shear walls with staggered openings required abundant less reinforcement than the shear walls with vertical openings. The most conclusion of the study is that solid shear walls area unit the foremost stable varieties of shear walls, if purposeful flexibility must be provided it shall be within the sort of coupled shear walls or by the availability of staggered openings at edge.

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